Snow Day Teacher Guide

Middle School Earth and Space Science

Three-Dimensional Claim

In this task, students apply their understanding of atmospheric conditions and weather patterns to predict future weather conditions by using models to explain the pattern of snowfall in the more northern city of Knoxville and to develop a model to explain an atypical event of how Chattanooga received snow while Knoxville (which has a similar longitude) did not, by showing a cause and effect relationship can be used to predict phenomena in a natural system.

Tennessee Academic Standards for Science

This task is intended to elicit student learning of the following Tennessee Science Standard:

- **6.ESS2.6:** Explain how relationships between the movement and interactions of air masses, high and low pressure systems, and frontal boundaries result in weather conditions and severe storms.
- **6.ESS2.5**: Analyze and interpret data from weather conditions, weather maps, ~~satellites, and radar~~ to predict probable local weather patterns and conditions.

Next Generation Science Standards

This task is intended to elicit student learning of the following NGSS elements for each of the three dimensions:

Science and Engineering Practices
Developing and Using Models

- *Middle School Element:* Develop and /or use a model to predict and/or describe phenomena.
- *Middle School Element:* Develop or modify a model — based on evidence — to match what happens if a variable or component of a system is changed.

Analyzing and Interpreting Data

- *Middle School Element:* Analyze and interpret data to provide evidence for phenomena.

Disciplinary Core Ideas
ESS2.D Weather and Climate

- *Middle School Element*: Because these patterns are so complex, weather can only be predicted probabilistically.

Crosscutting Concepts
Cause and Effect: Mechanism and Prediction

- *Middle School Element*: Cause and effect relationships may be used to predict phenomena in natural ~~or designed~~ systems.

System and System Models

- *Middle School Element*: Models are limited in that they only represent certain aspects of the system under study.

***Note**: The strikeout language is not targeted in this assessment.*

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Suggestions for Use

This task should be used as a summative assessment after a series of Tennessee Science Standards is taught (ESS2.2, ESS2.3, ESS2.5, and ESS2.6). It can elicit student sensemaking using practices (modeling), crosscutting concepts (cause and effect), and the core ideas in the context of a phenomenon. A student checklist should be provided to students before they begin the task to read over and to refer to during the completion of each prompt.

Assumptions

The task is predominantly built upon weather maps (both interpretation and development/modification). Students should also have had practice with predicting the weather using data collected from weather instruments and predicting weather from a probability standpoint and understand why weather can only be predicted this way. If students have not engaged in practices around weather maps , how air masses move, or zoom in features of air density this would be a very difficult task.

Logistics

This task can be completed in one or two class periods depending on class time. Color on the weather maps is not needed so copies can be made in black and white, however if teachers want to show the colors the maps could be displayed for the whole class by projector or on a TV.

The student Checklist should be given to students at the beginning of the task to read over before they begin and to be used to check off when they feel they are finished with each prompt.

Scoring Guide

26-27/27 = **Mastered** the 3 dimensions of task
22-25/27 = **On Track** for DCI knowledge, may need more exposure to identifying SEPs, CCCs
18-21/27 = **Approaching** grade level content knowledge, needs more exposure to DCIs, SEPs, & CCCs
0-17/27 = **Below** grade level content in all 3 dimensions of task, reteaching and remediation needed.

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Color Key

Orange = DCI
Blue = Science and Engineering Practice
Green = Cross Cutting Concept
Red = Focus for Question

Rubric for Task 1 Part A and B

Rubric measures: (3 points) Student analyzes data to provide evidence for snow.

Performance Expectation	Alignment to PE Dimensions Assesses	Question Assessed
Students can apply their understanding of atmospheric conditions and weather patterns to predict future weather conditions by using models to explain the pattern of snowfall in the more northern city of Knoxville and to develop a model to explain an atypical event of how Chattanooga received snow while Knoxville, being at a similar longitude, did not by showing a cause and effect relationship can be used to predict phenomena in a natural system.	*Science Practice (NGSS and TN):* **Analyze and Interpret data** to provide evidence for phenomena. *Crosscutting Concept (NGSS and TN):* **Cause and effect** may be used to predict phenomena in natural ~~or designed~~ systems. *Disciplinary Core Idea (TN):* **TN.6.ESS2.5** - Analyze and interpret data from weather conditions, weather maps, satellites, and radar to predict probable local weather patterns and conditions. *Disciplinary Core Idea (NGSS):* **ESS2.D** Because these patterns are so complex, weather can only be predicted probabilistically.	T1 - Use the scenario above and table below of the weather for the weather event to answer the following question: **Part A:** Based on the scenario and the weather data in the table above, on which day and in which city was snowfall happening? A) Wednesday in Knoxville B) Tuesday in Knoxville C) Wednesday in Chattanooga D) Monday in Chattanooga **Part B:** Explain your selection from Part A and include your reasoning for why snow would not be predicted on the other days and not in the other city.

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Rubric for Task 1 Part A and B

Rubric measures: (3 points) Student analyzes data to provide evidence for snow.

	Basic +1	**Approaching +2**	**On Track +3**	
Description of performance	Student identifies correct day and city for snow but does not explain the choice relating temperature and precipitation.	Student identifies the correct day and city but only identifies one factor, below freezing temperature or precipitation as a reason.	Student chooses correct day and city and analyzes the data to explain the relationship between the below freezing temperature with precipitation lead to snow to identify the correct day and why the other days in the data table could not be correct because they are missing one of the factors for snow and the scenario conveyed that Chattanooga was the only city to get snow.	
Sample Student answer	*C (no explanation)* *Or* *C, It was coldest there* ***If student does not answer the question parts correctly, there is a good chance they will not be able to continue and need more opportunities for learning.*	*C, I chose Wednesday because it was below freezing in Chattanooga.* *Or* *I chose Wednesday because it had precipitation in Chattanooga.*	*C, The Precipitation type is dependent on temperature (on average, below freezing 32°F) will be snow or hail like Wednesday, and above freezing will be rain like Tuesday and Friday). Below freezing temps without precipitation will just be a cold day like Monday and Thursday. The scenario said Chattanooga was the only city to have snow.*	
Potential student feedback	*Can you tell me why snow forms instead of rain? What factors in the data can help you decide?*	*I like how you correctly identified the day, I would like you to use all of the factors in the data to explain the snow.*		

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Rubric for Task 2 Part A and B

Rubric measures: (4 points) Student revises a model to show the relationships between air pressure, temperature, and frontal boundaries resulting in specific weather conditions.

Performance Expectation	Alignment to PE Dimensions Assesses	Question Assessed
Students can apply their understanding of atmospheric conditions and weather patterns to predict future weather conditions by using models to explain the process of how Chattanooga received snow while Knoxville, being at a similar longitude, did not and to develop a model to predict a future weather events showing a cause and effect relationship can be used to predict phenomena in a natural system.	*Science Practice (NGSS and TN):* **Developing and Using Models** to predict and/or describe phenomena. *Crosscutting Concept (NGSS and TN):* **Cause and effect** relationships may be used to predict phenomena in natural ~~or designed~~ systems. *Disciplinary Core Ideas (TN):* **TN.6.ESS2.5** - Analyze and interpret data from weather conditions, weather maps, ~~satellites, and radar~~ to predict probable local weather patterns and conditions. **TN.6.ESS2.6**- Explain how relationships between the movement and interactions of air masses, high and low pressure systems, and frontal boundaries result in weather conditions and severe storms. *Disciplinary Core Idea (NGSS):* **ESS2.D** Because these patterns are so complex, weather can only be predicted probabilistically.	T2- A: Label the type of front in zoom in feature #1. Describe the air, moisture conditions, and any severe weather associated with this type of front below. B: Label the type of front in zoom in feature #2. Describe the air, moisture conditions, and any severe weather associated with this type of front below.

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Rubric for Task 2 Part A and B

Rubric measures: (4 points) Student revises a model to show the relationships between air pressure, temperature, and frontal boundaries resulting in specific weather conditions.

	Emerging +1	Developing +2	Proficient +3	Advanced +4
Description of performance	Student labels both fronts correctly and gives very little detail about the conditions associated with fronts. *No answer/ incorrect answer = no points	Student labels both fronts correctly and gives some correct information on either the air or moisture conditions associated with the fronts	Student labels both fronts correctly and gives some accurate information about air temperatures associated with the front, moisture levels before and after the front.	Student labels both fronts correctly and uses typical cause and effect patterns of fronts to give accurate air pressure, speed of fronts, basic air temperatures, moisture associated before and after the front passes, and what happens when the two fronts collide.
Sample Student answer	On Map: *#1- Cold Front #2- Warm Front* *#1 Cold fronts bring cold air* *#2 Warm fronts bring warm air*	On Map: *#1- Cold Front #2- Warm Front* *#1 A cold front brings rain or snow at first and cold dry air after the front passes.* *#2 A warm front brings rain with warm air*	On Map: *#1- Cold Front #2- Warm Front* *#1 A cold front typically comes in strong with storms that can have rain, snow, or tornadoes especially when it meets warmer air and after it passes colder air moves in.* *#2 A warm front typically comes in slow and brings steady rain and after it passes warmer air moves in.*	On Map: *#1- Cold Front #2- Warm Front* *#1 The typical weather pattern conditions for a cold front are a fast moving air mass having cold dry air with high pressure behind the frontal boundary. At the frontal boundary there can be severe storms especially if it runs into a warm air mass.The cold air pushes the warm air up and it condenses quickly leading to storms.* *#2 Typical weather pattern conditions for a warm front are a slow moving air mass having warm moist air with low pressure behind the frontal boundary. At the frontal boundary a steady rain will fall and can last hours to days.*
Potential student feedback	You accurately identified the different types of air temperatures with the fronts. What other predicted patterns of weather conditions can you expect with these fronts?	You identified temperature and precipitation types correctly on cold and warm fronts, what are other patterns of weather conditions you would expect to see with these fronts?		

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Rubric for Task 2 Part C

Rubric measures: (4 points) Student revises a model to show the relationships between air pressure, temperature, and frontal boundaries resulting in specific weather conditions.

Performance Expectation	Alignment to PE Dimensions Assesses	Question Assessed
Students can apply their understanding of atmospheric conditions and weather patterns to predict future weather conditions by using models to explain the pattern of snowfall in the more northern city of Knoxville and to develop a model to explain an atypical event of how Chattanooga received snow while Knoxville, being at a similar longitude, did not by showing a cause and effect relationship can be used to predict phenomena in a natural system.	*Science Practice (NGSS and TN):* **Developing and Using Models** to predict and/or describe phenomena. *Crosscutting Concept (NGSS and TN):* **Cause and effect** relationships may be used to predict phenomena in natural ~~or designed~~ systems. *Disciplinary Core Idea (TN):* **TN.6.ESS2.5**- Analyze and interpret data from weather conditions, weather maps, ~~satellites, and radar~~ to predict probable local weather patterns and conditions. **TN.6.ESS2.6**- Explain how relationships between the movement and interactions of air masses, high and low pressure systems, and frontal boundaries result in weather conditions and severe storms. *Disciplinary Core Idea (NGSS):* **ESS2.D** Because these patterns are so complex, weather can only be predicted probabilistically.	C: Draw (on the map) and explain (below) what the air pressure and moisture levels of the two different cities would look like using the zoom in features (#3 and #4) Be sure to use the key on the map . ***The representation is showing their understanding of density and/or pressure, these are sister concepts in air masses so either term can be used in explanations.**

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	Emerging +1	Developing +2	Proficient +3	Advanced +4
Description of performance	Student uses the model to represent high density/air pressure by drawing several circles in both cities. Knoxville- they will represent high moisture by drawing in several triangles. Chattanooga- would have less triangles showing low moisture. *Student could also draw 1-4 triangles for Chattanooga and still show accurate reasoning. *If student does not represent high density/pressure in both cities = no points	Student uses the model to represent high density/air pressure by drawing many circles in both cities. Knoxville- they will represent high moisture by drawing in many triangles. Chattanooga- would have less triangles showing low moisture. Student gives some explanation of why Knoxville and Chattanooga have lots of circles-more dense air/high pressure, The reasoning for fewer triangles in Chattanooga may not be evident.	Student completes the model to represent high density/air pressure by drawing many circles in both cities. Knoxville- they will represent high moisture by drawing in many triangles. Chattanooga- would have less triangles showing low moisture. Student gives some reasoning but does not *fully* explain either: Why Knoxville and Chattanooga have higher density of air particles or Why Knoxville and Chattanooga have different amounts of moisture.	Student uses the model's location of the fronts on the map to represent high density/air pressure by drawing many circles in both cities. Knoxville- they will represent high moisture by drawing in many triangles. Chattanooga- would have less triangles showing low moisture. Student fully explains the temperature and pressure causes the high density of air particles and the high or low amount of moisture is a result of interactions of frontal boundaries or lack of interactions on the model.
Sample Student answer	 #3 #4 *#3 Knoxville-Cold air means close together circles, storms mean lots of triangles for moisture.* *#4 Chattanooga- Cold air means close together circles, no storms so a few triangles*	 #3 #4 *#3 Knoxville-cold air is denser (lots of circles). There is lots of moisture (lots of triangles) because of the two fronts.* *#4 Chattanooga- cold air is more dense (lots of circles) and low moisture (few triangles)*	 #3 #4 #3 Knoxville-There are many circles because *cold air has higher pressure and is denser. There are also lots of triangles because there is high moisture from the warm front.* *#4 Chattanooga- many circles due to high pressure from the cold air. There are very few triangles because there is not another front bringing moisture.*	 #3 #4 *#3 Knoxville- The air particles (circles) are close together because cold air has higher pressure and is denser. There are many water particles (triangles) because of precipitation from the frontal boundaries interacting in the map. The moisture particles condense and fall as snow here.* *#4 Chattanooga- The air particles are close together because cold air has high pressure and density. There are less water particles because there are no fronts interacting causing precipitation.*
Possible student feedback	You have correctly filled in the zoom in circles with air and water particles and explained why Knoxville had more moisture. Can you explain what the air pressure is doing in these two cities?		You made a connection between temperature and air pressure, and also between moisture and fronts interacting in both the zoom in and the explanation. Can you use the completed model to explain which city is getting snow and which is not?	

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Rubric for Task 2 Part D

Rubric measures: (4 points) Student revises a model to show the relationships between air pressure, temperature, and frontal boundaries resulting in specific weather conditions.

Performance Expectation	Alignment to PE Dimensions Assesses	Question Assessed
Students can apply their understanding of atmospheric conditions and weather patterns to predict future weather conditions by using models to explain the pattern of snowfall in the more northern city of Knoxville and to develop a model to explain an atypical event of how Chattanooga received snow while Knoxville, being at a similar longitude, did not by showing a cause and effect relationship can be used to predict phenomena in a natural system.	*Science Practice (NGSS and TN):* **Developing and Using Models** to predict and/or describe phenomena. *Crosscutting Concept (NGSS and TN):* **Cause and effect** relationships may be used to predict phenomena in natural ~~or designed~~ systems. *Disciplinary Core Idea (TN):* **TN.6.ESS2.5**- Analyze and interpret data from weather conditions, weather maps, satellites, and radar to predict probable local weather patterns and conditions. **TN.6.ESS2.6**- Explain how relationships between the movement and interactions of air masses, high and low pressure systems, and frontal boundaries result in weather conditions and severe storms. *Disciplinary Core Idea (NGSS):* **ESS2.D** Because these patterns are so complex, weather can only be predicted probabilistically.	D: Explain how the interactions between the air masses (using and the air pressure and moisture conditions you described in your zoom in circles) resulted in the normal weather conditions of the two cities.

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Rubric for Task 2 Part D

Rubric measures: (4 points) Student revises a model to show the relationships between air pressure, temperature, and frontal boundaries resulting in specific weather conditions.

	Emerging +1	Developing +2	Proficient +3	Advanced +4
Description of performance	Student just briefly describes one aspect of air pressure or moisture.	Student describes air temperature as it related to pressure and moisture levels in a city due to interactions between frontal boundaries but fails to understand or show reasoning for why that is different for the other city.	Student accurately describes the difference in above and below freezing temperatures, the pressure as it relates to temperature, and the moisture levels of both cities because of interactions of frontal boundaries	Student accurately describes the difference in temperature and moisture levels and the similarity of air pressure of the two cities because of interactions of frontal boundaries. Knoxville has a below freezing temperature and high moisture, Chattanooga has an above freezing temperature and low moisture. Both cities have high pressure.
Sample Student answer	*#3 Knoxville has more moisture as snow* *#4 Chattanooga does not have snow*	*#3 Knoxville has snow because precipitation was brought up by the warm front and met the cold enough air from the cold front to have snow.* *#4 Chattanooga does not have snow*	*#3- Knoxville would have cold below freezing air and snow because a cold front and warm front came together over Knoxville bringing precipitation as snow.* *#4 Chattanooga would have cold above freezing air with high pressure so if there was any precipitation it would be rain.*	*#3-Knoxville would have snow due to cold below freezing air with high pressure and high moisture because the two fronts met right over Knoxville bringing high precipitation.* *#4- Chattanooga would only have cold dry air with high pressure and very little moisture because there are no air masses colliding causing high precipitation. If there was any precipitation, it would have been rain because the temperature was above freezing.*
Possible student feedback		You correctly identified the interactions of air masses and precipitation type in Knoxville. If you included more detail about the interactions of the air masses in Chattanooga, then you would have a complete answer.		

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Rubric for Task 3

Rubric measures: (4 points) Students use data charts and maps to identify the cause and effect pattern of more yearly snowfall in higher latitudes and elevations.

Performance Expectation	Alignment to PE Dimensions Assesses	Question Assessed
Students can apply their understanding of atmospheric conditions and weather patterns to predict future weather conditions by using models to explain the pattern of snowfall in the more northern city of Knoxville and to develop a model to explain an atypical event of how Chattanooga received snow while Knoxville, being at a similar longitude, did not by showing a cause and effect relationship can be used to predict phenomena in a natural system.	*Science Practice (NGSS and TN):* **Developing and Using Models** to predict and/or describe phenomena. **Analyze and Interpret data** to provide evidence for phenomena. *Crosscutting Concept (NGSS and TN):* **Cause and effect** relationships may be used to predict phenomena in natural ~~or designed~~ systems. *Disciplinary Core Idea (TN):* **TN.6.ESS2.5**- Analyze and interpret data from weather conditions, weather maps, ~~satellites, and radar~~ to predict probable local weather patterns and conditions. **TN.6.ESS2.6**- Explain how relationships between the movement and interactions of air masses, high and low pressure systems, and frontal boundaries result in weather conditions and severe storms.	T3 - Using all of the maps and data tables above, what factors could lead to the typical pattern of Knoxville receiving more annual snowfall than Chattanooga?

	Emerging +1	Developing +2	Proficient +3	Advanced +4
Description of performance	Student does not show any use of the data or maps to reason out snowfall.	Student uses the data or the map but does not show an accurate reasoning for a relationship between latitude and temperature.	Student uses the data and/or the map and shows the relationship of latitude and temperature allowing for more snowfall per year.	Student reasoning is clear and accurate. They show use of the data table and the maps to recognize that Knoxville is at a higher latitude than Chattanooga. (Student may even have knowledge of or infer a higher elevation for Knoxville.)
Sample Student answer	*Knoxville is colder than Chattanooga because it is farther north.*	*The data table shows all of the northern cities get more snow every year so the factor must be being farther north.*	*The map shows that Knoxville is farther north than Chattanooga and therefore would be colder. Latitude would be a factor in the pattern of more yearly snowfall.*	*The data table and the map show that cities with higher latitudes get more snow per year. Therefore the main factor that could lead to a pattern of more annual snowfall in Knoxville is having a higher latitude than Chattanooga. Knoxville also may have a higher elevation since it is so close to the Smoky Mountains which could be another factor.*
Possible Student Feedback	You recognized that a city that is farther north (latitude) plays in role temperature. Can you cite evidence in the map and data sets in the task to identify this factor?	Can you explain your reasoning in the data and how the map also helps describe a pattern between temperature and being farther north (latitude).		

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Rubric for Task 4 Part A and B

Rubric measures: (4 points) Student develops and uses a model to explain what conditions are needed for a non typical pattern of more snow in the lower latitude city of Chattanooga.

Performance Expectation	Alignment to PE Dimensions Assesses	Question Assessed
Students can apply their understanding of atmospheric conditions and weather patterns to predict future weather conditions by using models to explain the pattern of snowfall in the more northern city of Knoxville and to develop a model to explain an atypical event of how Chattanooga received snow while Knoxville, being at a similar longitude, did not by showing a cause and effect relationship can be used to predict phenomena in a natural system.	*Science Practice (NGSS and TN):* **Developing and Using Models** based on evidence, to match what happens if a variable or component of a system is changed. *Crosscutting Concept (NGSS and TN):* **Cause and effect** relationships may be used to predict phenomena in natural ~~or designed~~ systems. *Disciplinary Core Idea (TN):* **TN.6.ESS2.5**- Analyze and interpret data from weather conditions, weather maps, satellites, and radar to predict probable local weather patterns and conditions. **TN.6.ESS2.6**- Explain how relationships between the movement and interactions of air masses, high and low pressure systems, and frontal boundaries result in weather conditions and severe storms. *Disciplinary Core Idea (NGSS):* **ESS2.D** Because these patterns are so complex, weather can only be predicted probabilistically.	T4 - Below is a partially completed weather map of Eastern Tennessee. a. Draw on this map to develop a model that shows the pattern and conditions that needed to emerge for it to snow in Chattanooga and not Knoxville on February 1, 2015. b. Describe how your map explains snow in Chattanooga and not Knoxville on February 1, 2015.

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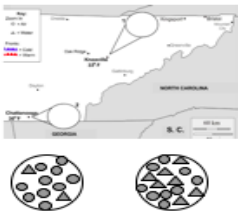
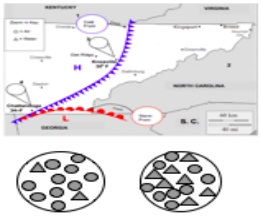
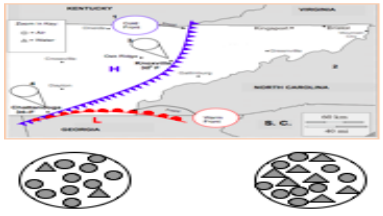
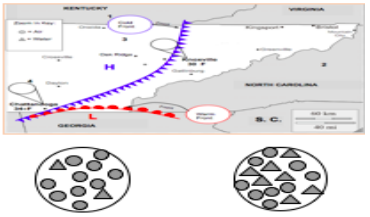
	Emerging +1	Developing +2	Proficient +3	Advanced +4
Description of performance	Part A- Student correctly draws the zoom in features for Chattanooga and Knoxville but does not draw the pressure or fronts in correctly or they are missing. Part B- Student does not accurately describe how a change of location in the warm front will allow for Chattanooga but not Knoxville to receive snow.	Part A- Student correctly draws the zoom in features for Chattanooga and Knoxville and the two fronts are drawn in accurately. Pressure is missing from the map or incorrect. Part B- Student describes the cause & effect relationship between the two fronts meeting over Chattanooga, below freezing temperatures and snow but shows no reasoning for Knoxville.	Part A- Student can show some reasoning by accurately draw 2 out of the 3 parts: the cold front can be either in front of or past Knoxville but warm front should be drawn meeting it over Chattanooga. The high pressure should be behind (left of) the cold front symbol, the low pressure should be below the warm front symbol. The Zoom in for Chattanooga should show more moisture and high density/pressure. Knoxville should show less moisture and high density/pressure. Part B- Student describes how the changing location of the warm front allows for a more southern city with freezing temperatures to have snow. Without enough moisture Knoxville did not have snow, it was just a cold day.	Part A- Student accurately draws all 3 parts: the correct locations of the cold and warm fronts, air pressure, and accurately draws zoom in features showing more moisture in Chattanooga and less in Knoxville with high density/air pressure in both cities. Part B- Student describes their reasoning for how the effect of changing location of the warm front allows for a more southern city with freezing temperatures to have snow. Without enough moisture Knoxville did not have snow, it was just a cold day. Student may also identify that pressure systems move from high to low so the high pressure system is moving too fast for the warm front to make it to Knoxville.
Sample Student answer	 Knox. Chattanooga Part B *Chattanooga has colder temperatures so it will get snow while Knoxville is not cold enough to have snow.*	 Knox. Chattanooga Part B *Chattanooga has below freezing temperatures and a warm front has brought enough moisture for snow.*	 Knoxville Chattanooga Part B *Because the two fronts met over Chattanooga bringing moisture and the temperature was below freezing, Chattanooga received snow and Knoxville did not. Knoxville only had cold dry air since the moisture had not moved into that area.*	 Knoxville Chattanooga Part B *The two fronts met over Chattanooga this time while it already had below freezing temps. This allowed for the more southern city to get snow while the more Northern city of Knoxville has high pressure and almost freezing temperatures but there was no moisture in place to allow for snow.*
Possible student feedback	You recognized that Chattanooga had more moisture in the air and below freezing temperatures. Can you also draw and identify how the air masses interacting played a role in snow?			

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Red = Focus for Question

Rubric for Task 5

Rubric measures: (4 points) Student explains how a weather model is limited and can only represent certain aspects of the conditions leading to a probabilistic weather forecast.

Performance Expectation	Alignment to PE Dimensions Assesses	Question Assessed
Students can apply their understanding of atmospheric conditions and weather patterns to predict future weather conditions by using models to explain the pattern of snowfall in the more northern city of Knoxville and to develop a model to explain an atypical event of how Chattanooga received snow while Knoxville, being at a similar longitude, did not by showing a cause and effect relationship can be used to predict phenomena in a natural system.	*Science Practice (NGSS and TN):* **Developing and Using Models** to predict and/or describe phenomena. *Crosscutting Concept (NGSS and TN):* **Cause and effect** may be used to predict phenomena in natural ~~or designed~~ systems.(Also addressing: **Systems and System Models** Models are limited in that they only represent certain aspects of the system under study.) *Disciplinary Core Idea (TN):* **TN.6.ESS2.5** - Analyze and interpret data from weather conditions, weather maps, satellites, and radar to predict probable local weather patterns and conditions. **TN.6.ESS2.6**- Explain how relationships between the movement and interactions of air masses, high and low pressure systems, and frontal boundaries result in weather conditions and severe storms. *Disciplinary Core Idea (NGSS):* **ESS2.D** Because these patterns are so complex, weather can only be predicted probabilistically.	T5- In a weather report on January 28th, a meteorologist predicted, "There is a 60% chance of snow in Knoxville and a 15% chance of snow in Chattanooga on February 1st." On February 1st, snow fell in Chattanooga but not in Knoxville. Why are weather maps not 100% accurate at predicting the weather?

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Rubric for Task 5

Rubric measures: (4 points) Student explains how a weather model is limited and can only represent certain aspects of the conditions leading to a probabilistic weather forecast.

	Emerging +1	Developing +2	Proficient +3	Advanced +4
Description of performance	Student identifies that weather conditions are always changing but does not connect the limitations of the map to the percent chance forecast.	Student identifies that weather maps and meteorologists have a hard time making weather predictions because weather maps are a moment in time and conditions may change after the forecast is made.	Student identifies that a weather map (model) has limitations and cannot make a completely accurate prediction for the future because weather factors are changing all of the time.	Student should identify that because a weather map (model) has limitations it cannot make a completely accurate prediction because weather factors are changing all of the time. Student should identify that a probable prediction is the way a meteorologist would convey that forecast because some areas may have those conditions and some will not.
Sample Student answer	*Weather is always changing and sometimes meteorologists get the forecast wrong so they want to give it as a percent chance.*	*Weather maps are not accurate at predicting the weather because weather conditions change and once the meteorologist makes a prediction then something else could change.*	*Weather maps are limited because they show the current conditions so when a meteorologist makes a prediction those conditions will likely change. The best way to make a prediction is with a percent chance, that way a percentage of that area may get that weather.*	*Weather maps and computer models have limitations and so do the predictions based on them. There are other factors that can change so quickly like wind speed and timing so when a forecast is made, a meteorologist gives a percent chance because it is the best prediction for the area. Some in that area may get that weather and some may not.*
Possible student feedback	You identified that weather conditions are always changing. Can you tell me what the weather map has to do with that prediction and leads to the forecast given in a probability format?			